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Indian Standard

SPECIFICATION FOR
ELECTRICAL MEASURING INSTRUMENTS
FOR EXPLOSIVE GAS ATMOSPHERES

(*First Revision*)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Indian Standard

SPECIFICATION FOR ELECTRICAL MEASURING INSTRUMENTS FOR EXPLOSIVE GAS ATMOSPHERES

(*First Revision*)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards on 8 January 1988, after the draft finalized by the Electrical Measuring Instruments Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard specifies the general requirements for construction testing and marking of electrical apparatus for explosive gas atmospheres and to be read with the following Indian Standards concerning specific types of protection:

IS : 2148-1981 Specification for flameproof enclosures of electrical apparatus (*second revision*)

IS : 5780-1980 Specification for intrinsically safe electrical apparatus and circuits (*first revision*)

IS : 6381-1972 Construction and testing of electrical apparatus with type of protection '*e*'

IS : 7389 (Part 1)-1976 Specification for pressurized enclosure with no internal

source of flammable gas or vapour (*first revision*)

IS : 8289-1976 Specification for electrical equipment with type of protection '*n*'

0.3 For the purpose of this standard, wherever there is reference to other standard(s), latest version of the referred standard(s) shall be applicable.

0.4 While preparing this standard, assistance has been derived from all parts of IEC Pub 79 'Electrical apparatus for explosive gas atmosphere' issued by the International Electrotechnical Commission.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard covers requirements and tests for the following direct acting electrical indicating instruments (including multirange instruments) for use in hazardous atmospheres:

- a) Ammeters,
- b) Voltmeters,
- c) Wattmeters (single and polyphase),
- d) Varimeters,
- e) Power factor indicators,
- f) Frequency meters (pointer and vibrating reed type), and
- g) Ohmmeters (non-ratio type).

1.2 This also applies to electrically measuring equipments provided that electrically measuring indicating instrument (receiver) only is considered, and that the law for translation from non-electrical quantity to the electrical one is known.

1.3 This standard is applicable to electrical apparatus for explosive gas atmospheres where atmospheric conditions for the explosion characteristics of the explosive gas atmosphere are considered as having pressures in the range 80 (0.8 bar) to 110 kPa (1.1 bar) at a temperature in the range -21°C to +40°C. Atmospheric conditions outside this range may need special consideration.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following

definitions in addition to those given in IS : 5572 (Part I)-1970* and IS : 2148-1968†, shall apply.

2.1 Flameproof Enclosure — An enclosure for electrical instrument that will withstand, when the covers or other access doors are properly secured, an internal explosion of the flammable gas or vapour which may enter or which may originate inside the enclosure, without suffering damage and without communicating the internal flammation (or explosion) to the external flammable gas or vapour in which it is designed to be used through any joints or other structural openings in the enclosure.

2.2 Plate Protection — The type of protection in which the parts capable of igniting flammable mixtures are enclosed in an enclosure having openings with special fittings (plate protection stacks) such that, in case of an internal explosion, a dangerous pressure rise is avoided and transmission of the explosion to the flammable mixture outside the enclosure is prevented.

2.3 Pressurized Enclosure — An enclosure for instruments in which the parts are capable of igniting flammable or explosive mixture are enclosed in enclosures, which are scavenged by fresh air or inert gases (protective gas) under pressure so that fire damp or explosive mixture which have entered the enclosure before the apparatus was put into operation are expelled and may not enter the enclosures during operation.

2.4 Intrinsically-Safe Circuit — A circuit in which any spark or thermal effect produced either normally or in specified fault conditions is incapable, in the test conditions prescribed in this standard, of causing ignition of a given gas or vapour.

2.4.1 Intrinsically-Safe Apparatus — Apparatus in which all the circuits are intrinsically safe.

2.5 Special Fastenings — Fastenings which may only be opened with special means (for example, triangular shrouded bolt).

2.6 Creepage Distance — The shortest path by which a current may pass over the surface of an insulator or through joints of insulators joined together.

2.7 Clearance — The shortest path in air as measured by a taut string, over which current may pass (flashover).

2.8 Limiting Temperature — It is the maximum permissible temperature of apparatus of parts of apparatus. It is determined by the:

- a) danger of ignition of the explosive gas atmosphere, and

*Classification for hazardous areas for electrical installations: Part I Areas having gases and vapours.

†Specification for flameproof enclosures of electrical apparatus (first revision).

b) thermal stability of the materials used.

The lower temperature is the one to be taken into consideration.

2.9 Ignition Temperature — The lowest temperature at which ignition occurs under specified test conditions.

2.10 Maximum Surface Temperature — The highest temperature attained under practical conditions of operation within the rating of the apparatus (and recognized overloads, if any) by any part of any surface, the exposure of which to an explosive atmosphere may involve a risk.

NOTE — For flameproof apparatus, the surface to be considered is the external surface. For other types of apparatus, internal surfaces are equally important, if the explosive atmosphere has access to them.

2.11 Spacings — The shortest distance between two reference points irrespective of the material between them (air, oil, compound).

NOTE — Creepage distance, clearance and spacings occur between:

- a) live parts at different voltages,
- b) live parts and earthed parts,
- c) live parts and points accessible to contact or metal parts, and
- d) live parts and supports (walls, etc).

When determining creepage distances, clearances and spacings, it should be noted that live parts which are only varnished, enamelled, oxidized or surface-treated in a similar manner are not considered as insulated.

2.12 Type of Protection 'e' — The type of protection 'e' is the method of protection by which additional measures are applied, so as to give increased security against the possibility of excessive temperatures and of the occurrence of arcs and sparks in apparatus which does not produce arcs or sparks in normal service.

2.13 Thermal Current Limit I_{th} — The rms value of current which may flow through parts for one second without causing excessive heating.

2.14 Dynamic Current Limit I_{dyn} — The peak value of the current, the forces due to which the electrical apparatus may withstand without damage.

2.15 Type Tests — Tests carried out to prove conformity with the requirements of specification. These are intended to prove the general qualities and design of a given instrument.

2.16 Routine Tests — Tests carried out on each instrument to check requirements which are likely to vary production.

3. GROUPING AND CLASSIFICATION OF ELECTRICAL MEASURING INSTRUMENTS

3.1 Electrical measuring instruments for explosive

gas atmospheres is divided into (see IS : 2148-1981*):

Group I — Electrical measuring instruments for mines susceptible to fire-damp.

Group II — Electrical measuring instruments for all places with an explosive gas atmosphere, other than mines susceptible to fire-damp.

3.1.1 For mines where gases other than fire-damp may normally and naturally occur, the electrical measuring instruments shall be not only constructed in accordance with Group I requirements, but shall also be submitted to the tests prescribed for the appropriate Group II explosive mixture and marked accordingly.

3.2 Electrical measuring instruments of Group II is subdivided according to the nature of the explosive gas atmosphere for which it is intended.

3.2.1 For certain types of protection, the subdivision IIA, IIB, IIC is prescribed; this is based on the maximum experimental safe gap (MESG) for flameproof enclosures or on the minimum igniting current (MIC) for intrinsically safe electrical measuring instruments (see IS : 9570-1980†).

NOTE — Measuring instruments marked IIB is suitable for applications requiring Group IIA measuring instruments. Similarly, measuring instruments marked IIC is suitable for applications requiring Group IIA and Group IIB measuring instruments.

3.2.2 For all types of protection, the temperature classes T_1 to T_6 correspond to the classification of electrical apparatus according to its maximum surface temperature (see Table 1).

3.3 Electrical measuring instruments may be tested for a particular explosive gas atmosphere. In this case it shall be certified and marked accordingly.

4. TEMPERATURE

4.1 Electrical measuring instruments for explosive gas atmospheres shall normally be designed for operation in an ambient temperature range from -20°C to $+40^{\circ}\text{C}$. Where the electrical measuring instruments is suitable for a temperature range which differs from this, the range shall be marked accordingly. The temperature classification, 'T' class as given in Table 1, shall be based on the maximum temperature of the ambient temperature range for which the measuring instruments is designed.

4.2 The maximum surface temperature shall not exceed:

- a) for Group I electrical measuring instruments;

*Specification for flameproof enclosures of electrical apparatus (*second revision*).

†Classification of flammable gases or vapours with air according to their maximum experimental safe gaps and minimum igniting currents.

1) 90°C where instruments are likely to be touched in normal use,

2) 135°C if the above risk is avoided, that is, instruments are not likely to come in contact with the personnel directly.

b) for Group II electrical measuring instruments; the value in Table 1 which corresponds to the temperature class of the electrical measuring instruments.

NOTE — When choosing electrical measuring instruments the Group II, the user should take into account the influence and the smouldering temperature of dusts if they are likely to be deposited in a layer.

TABLE 1 CLASSIFICATION OF MAXIMUM SURFACE TEMPERATURE FOR GROUP II ELECTRICAL MEASURING INSTRUMENTS

(*Clauses 3.2.2, 4.1, 4.2 and 4.3*)

Temperature class	T_1	T_2	T_3	T_4	T_5	T_6
Maximum surface temperature (°C)	450	300	200	135	100	85

4.3 For Group II electrical measuring instruments, if a maximum surface temperature different from those given in Table 1 is selected, this temperature shall be indicated on the electrical measuring instruments concerned.

4.4 The maximum surface temperature of the electrical measuring instruments shall be below the lowest ignition temperature of the explosive gas atmospheres for which the electrical measuring instrument is designed. However, for components having a total surface area of not more than 10 cm^2 (for example, transistors or resistors used in intrinsically safe electrical circuits), their surface temperature may exceed that for the temperature class marked on the electrical measuring instruments if there is no direct or indirect risk of ignition from these components with safety margin of:

- a) 50°C for T_1 , T_2 and T_3 ; and
- b) 25°C for T_4 , T_5 and T_6 .

This safety margin shall be ensured by experience of similar components or by test of the electrical measuring instruments itself in explosive mixtures having the appropriate thermal ignition characteristics (see IS : 8239-1976*).

NOTE — During the test, the safety margin may be verified by increasing the ambient temperature.

5. TYPES OF PROTECTION

5.1 Electrical measuring instruments for use in explosive gas atmosphere shall be provided with

*Classification of maximum surface temperature of electrical equipment for use in explosive atmospheres.

either one or combination of the following types of protection:

- a) Intrinsically safe electrical instrument,
- b) Pressurized enclosure,
- c) Flameproof enclosure,
- d) Type of protection 'e', and
- e) Plate protection (flame arrestor).

6. GENERAL CONSTRUCTIONAL REQUIREMENTS

6.1 General — In addition to the requirements specified in relevant part of IS : 1248*, the following requirements given in **6.1.1** to **6.2.4.7** shall be complied.

6.1.1 Electrical instruments shall be able to withstand the special conditions and fulfil the requirements of mining service (for example, rough handling, effect of moisture, purifying agents and dust, temperature differences, etc).

6.1.2 The design of electrical instruments for use in explosive gas atmosphere should be based on an ambient temperature of -40°C ;

6.1.3 Measuring instruments shall not be installed in the housing of circuit breaker provided with 'Flameproof Enclosure' or 'Plate Protection'.

6.2 Additional Requirements

6.2.1 Intrinsically-Safe Instrument — An intrinsically-safe instrument shall satisfy three basic requirements:

- a) Adequate separation from other circuits,
- b) All components in the circuit shall have a maximum surface temperature less than specified in IS : 5780-1980† in order to avoid ignition resulting from thermal effect, and
- c) No ignition due to spark shall result when the circuit is tested or checked.

6.2.1.1 In all other respects the instrument shall satisfy the requirements of IS : 5780-1980†.

6.2.2 Pressurized Enclosures

6.2.2.1 Pressurized enclosures shall conform to IS : 7389 (Part 1)-1976‡.

6.2.2.2 The method of pressurizing shall be such that the explosive mixtures which have entered the enclosures are scavenged and may not enter the enclosure during operation. The scavenging air shall be so directed that no such gas may remain in the corners of the enclosure.

*Specification for direct acting indicating analogue electrical-measuring instruments and their accessories.

†Specification for intrinsically safe electrical apparatus and circuits (*first revision*).

‡Pressurized enclosures of electrical apparatus for use in explosive atmospheres: Part I Pressurized enclosures with no internal source of flammable gas or vapour (*first revision*).

6.2.2.3 Pressurizing system shall be so arranged that, until a quantity of scavenging medium (air or inert gas) equal to five times the capacity of the enclosure has been passed through it, the electrical parts which might ignite the explosive mixtures cannot be put into operations.

6.2.2.4 If scavenging stops, the parts inside the enclosures which might ignite the explosive mixture should be put out of service or an alarm signal should be given.

6.2.2.5 To take care of static charge, all electrically conducting metal parts shall be properly earthed.

6.2.3 Flameproof Enclosure — The provisions of IS : 2148-1981* shall apply.

6.2.4 Type of Protection 'e'

6.2.4.1 The provisions of IS : 6381-1972† shall apply.

6.2.4.2 Measuring instruments and measuring transformers shall be able to withstand continuously 1·2 times their rated current I_n or their rated voltage without exceeding the limiting temperature specified in Table 1.

6.2.4.3 Current transformers and the current carrying parts of measuring instruments (excluding voltage circuits) shall be able to withstand thermal and mechanical stresses resulting from currents at least equal to the values stated in Table 2, with no reduction in their security against explosions.

TABLE 2 RESISTANCE TO THE EFFECT OF SHORT-CIRCUIT CURRENTS

CURRENT LIMIT	CURRENT CARRYING PARTS OF MEASURING INSTRUMENT	CURRENT TRANSFORMERS
(1) I_{th}	(2) $50 \times I_n$	(3) $100 \times I_n$
I_{dyn}	$*1.3 \times 125 I_n$	$*1.3 \times 250 I_n$

*The factor 1·3 is a factor of safety. From this it follows that the peak value of short circuit current permissible in service should not exceed $I_{dyn}/1.3$.

6.2.4.4 The temperature attained during the passage of a current equal to the thermal current limit I_{th} shall not exceed the lower limiting temperature specified in Table 1 and in no case shall it exceed 200°C .

6.2.4.5 Where the current carrying parts of measuring instruments are supplied by current transformers, the values of I_{th} and I_{dyn} need only

*Specification for flameproof enclosures of electrical apparatus (*second revision*).

†Specification for construction and testing of electrical apparatus with type of protection 'e'.

to equal to the current flowing in the short-circuited secondary windings of the current transformers with its primary windings carrying the currents I_{th} and I_{dyn} applicable to them (I_{dyn} is the dynamic current limit.)

6.2.4.6 Instruments with moving coils are not permitted.

6.2.4.7 If the current is fed to the moving part through strips, the stated voltage and current limit shall not be exceeded even in the case of contact with the frame or short circuit between strips.

- a) Type of protection 'e' may be applied to main supply apparatus provided at all loads (from no load to short circuit), the temperature and the temperature rise does not exceed the value given in Table 1.
- b) Instruments which are not portable should have an earthing terminal on its metal housing.
- c) Creepage distance shall be as far as practicable run in different planes. This may be achieved for instance by rounded ribs, breakages or recesses. Ribs shall have a minimum height and thickness of 3 mm. They shall be rounded with a minimum radius of 0.5 mm.
- d) Creepage distances and clearances shall not be reduced below the minimum permissible value by influences occurring in normal operation like mechanical and magnetic forces.

e) Creepage distance and clearances shall be not less than the values given in Table 3. The material for parts depending upon the creepage distances are given in Table 4.

7. MARKING

7.1 The instrument dial shall be clearly and indelibly marked in accordance with IS : 1248 (Part 1)-1983* and IS : 8241-1976†.

7.1.1 The instrument may also be marked with the Standard Mark.

NOTE — The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act 1986 and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

7.2 Measuring instruments and associated current transformers shall be marked as belonging together.

*Specification for direct acting indicating analogue electrical measuring instruments and their accessories: Part 1 General requirements (second revision).

†Method of marking for identifying electrical equipment for explosive atmospheres.

TABLE 3 MINIMUM VALUES OF CREEPAGE DISTANCES AND CLEARANCES

[Clause 6.2.4.7(e)]

INSULATION RATING dc Voltage (1)	ac Voltage (2)	CREEPAGE DISTANCE				CLEARANCE (7) mm	
		a mm (3)	b mm (4)	c mm (5)	d mm (6)		
24	24	6	6	6	6	6	
60	60	6	6	6	6	6	
110	125	6	6	8	10	6	
250	250	6	6	10	12	6	
440	440	6	8	12	14	6	
600	600	10	12	15	20	8	
660	750	14	18	22	28	10	
800	1 000	20	24	30	36	14	
1 200	1 500	28	32	40	50	20	
1 500	2 000	36	42	50	70	28	
	3 000	50	60	72	90	36	
3 000	6 000	90	110	130	160	60	
	10 000	125	150	180	240	100	

TABLE 4 MATERIALS OF PARTS
[Clause 6.2.4.7(e)]

CREEPAGE DISTANCE ACCORDING TO	TYPE	BINDING AGENT OR FILLER
(1)	(2)	(3)
a*	Ceramic materials Silicate glass Natural mica Mica Moulding compounds	— — — Inorganic Inorganic
b*	Mica Moulding compounds Moulding compounds Moulding compounds Ebonite Rubber	Organic Inorganic Inorganic Inorganic
c*	Moulding compounds Moulding compounds Moulding compounds Ebonite Rubber Laminated paper	Inorganic Organic Organic
d*	Laminated fabric Laminated paper Laminated fabric	Melamine resin Phenol resin

*These refer to Table 3.

8. TESTS

8.1 Type Tests

8.1.1 The type test is intended to prove safety against danger of explosion. It is carried out only on production samples after completion of the development of the types. Production samples in type of protection, 'plate protection', shall be tested in explosive mixture. Equipment in the types of protection 'pressurized enclosure' and 'e' need only be tested in explosive mixtures, if it is considered absolutely necessary according to relevant Indian Standard [see IS : 7389 (Part 1)-1976* and IS : 6381-1972†].

8.1.2 For instruments in types of protection 'flameproof enclosure', tests shall be carried out in accordance with IS : 2148-1981‡.

8.1.3 For instruments in type of protection 'flameproof enclosure' and 'plate protection', tests for internal pressure and test for flameproofness shall be carried out without the instrument. The enclosure alone shall be tested with all parts necessary for sealing including the window. If there is a chance of the interior parts causing objectionable subdivisions then the enclosure should be tested with the instrument fitted inside or a dummy may replace the instrument.

*Pressurized enclosures of electrical apparatus for use in explosive atmospheres : Part 1 Pressurized enclosures with no internal sources of flammable gas or vapour (*first revision*).

†Specification for construction and testing of electrical apparatus with type of protection 'e'.

‡Specification for flameproof enclosures of electrical apparatus (*second revision*).

8.1.3.1 The pressure test is not required in the case of plate protection system, if the free specific opening cross-section exceeds 80 mm²/l capacity.

8.1.3.2 To carry out the pressure tests, the test pressure shall be as specified in IS : 2148-1981*.

8.1.3.3 If the enclosure (flameproof or plate protected) remains unchanged after the pressure test, the test shall be regarded as having been passed.

8.1.4 For instruments in type of protection 'e', test for determining temperature rise shall be carried out. For this, the values of temperature shall be decided in accordance with Table 1. This test and other tests shall be carried out according to IS : 6381-1972†.

8.1.5 If the temperature rise of the short circuit strength and thus the safety of the instrument is dependent on additional apparatus, the effectiveness of the latter shall be tested.

8.1.6 The high voltage test on measuring instruments shall be carried out in accordance with IS : 1248 (Part 1)-1983‡, but at least a voltage of 2 000 volts shall be applied even in the case of rated voltages down up to 40 V.

8.2 Routine Tests

8.2.1 These tests are intended to find out any fault in material or manufacture and to verify compliance with minimum requirement to stand explosion hazards.

8.2.2 For instruments in type of protection 'flameproof enclosure' and 'plate protection', every dimensions, such as the gap, width, lengths or flamepath, gap between plates in the plate stacks and thickness of the plate shall be checked to ensure their adherence to permissible limits.

8.2.2.1 The test holes shall be carefully sealed after the test is carried out. It should be thoroughly checked to make sure that the seal can not work loose.

8.2.2.2 If during explosion test, no ignition takes place; during static test, no leakage takes place; and if the enclosure remains intact; then the test may be regarded as passed.

8.2.3 For instruments (in type of protection 'e'), voltage test shall be carried out in accordance with IS : 6381-1972†.

8.3 In addition the instrument shall be tested according to relevant part of IS : 1248.

*Specification for flameproof enclosures of electrical apparatus (*second revision*).

†Specification for construction and testing of electrical apparatus with type of protection 'e'.

‡Specification for direct acting indicating analogue electrical-measuring instruments and their accessories : Part General requirements (*second revision*).

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002

Telephones: 3310131, 3311375

Telegrams: Manaksanstha
(Common to all offices)

Regional Offices: Telephone

Central: Manak Bhavan, 9 Bahadur Shah Zafar Marg,
NEW DELHI 110002 3310131, 3311375

*Eastern: 1/14 C.I.T. Scheme VII M, V.I.P. Road, Maniktola,
CALCUTTA 700054 362499

Northern: SCO 445-446, Sector 35-C, CHANDIGARH 160036 21843, 31641

Southern: C.I.T. Campus, MADRAS 600113 412442, 412519, 412916

†Western: Manakalaya, E9 MIDC, Marol, Andheri (East)
BOMBAY 400093 6329295

Branch Offices: Telephone

'Pushpak' Nurmohamed Sheikh Marg, Khanpur, AHMADABAD 380001 26348, 26349

Peenya Industrial Area, 1st Stage, Bangalore-Tumkur Road,
BANGALORE 560058 384955, 384956

Gangotri Complex, 5th Floor, Bhadbhada Road, T.T. Nagar,
BHOPAL 462003 66716

Plot No. 82/83, Lewis Road, BHUBANESHWAR 751002 53627

53/5 Ward No. 29, R.G. Barua Road, 5th By-lane, GUWAHATI 781003 —

5-8-56C L. N. Gupta Marg (Nampally Station Road),
HYDERABAD 500001 231083

R14 Yudhister Marg, C Scheme, JAIPUR 302005 63471, 69832

117/418 B Sarvodaya Nagar, KANPUR 208005 216876, 218292

Patliputra Industrial Estate, PATNA 800013 62305

T.C. No. 14/1421, University P.O., Palayam, TRIVANDRUM 695035 76637

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